A Food Container

Description of the Invention

In accordance with the present invention, a monolithic construction novel food container 1, which can be heated in a microwave oven without distortion of its shape, without interfering with or overloading the microwave energy beam or the microwave radiant energy generation unit and without leakage even when the contained food reaches a boiling point, i.e., a temperature near 100 degrees Celsius, comprises;

an impermeable cavity 2 defined by i) a continuous seamless wall 3 with a periphery 4, said periphery having no folded gussets and is preferably polygonal in shape, for example rectangular, pentagonal, hexagonal or octagonal. Said periphery also having a top peripheral portion 5 and a bottom peripheral portion 6, and ii) a bottom surface 7, said bottom surface being hermetically, and preferably seamlessly or integrally, joined to said bottom peripheral portion 6 thereby forming the impermeable cavity 2, said wall and said bottom surface being made of a thermoplastic polymeric material, a set of at least two flaps 8, said

flaps being joined, and preferably integrally and seamlessly, to said top peripheral portion 5 at joining lines 9 located on said top peripheral portion, said flaps being made of same said thermoplastic polymeric material, said joining lines 9 being adapted to form flexural, and preferably living, hinges along substantially straight lines, said thermoplastic polymeric material having a glass transition temperature of at least -(negative) 20 degrees Celsius and/or a Heat Distortion Temperature, measured under a stress of 264 psi, in accordance with ASTM Standard Method No. D648, of at least 48 degrees Celsius, thereby enabling said container to contain food and sustain heating in a microwave oven without distortion of its shape, without interfering with or overloading the radiant energy generation unit and without leakage. Preferred examples of such thermoplastic polymeric materials are polypropylene and polystyrene.

As described above, the food container of the present invention is made of a thermoplastic polymeric material with a Heat Distortion Temperature of at least 48 °C and up to 200°C, (118°F to 392°F) including all 1°C range increments in between the range of 48°C to 200°C. In other words, the ranges of Heat Distortion Temperature

contemplated in this application are 48°C to 200°C, 49°C to 199°C, 50°C to 198°C, etc., through 122°C to 124°C. More broadly understood by those skilled in the art, is that any thermoplastic polymeric material that provides resistance to heat and mechanical stress in a microwave heating environment without reflecting the radiant energy beam and thus avoiding to overload the microwave energy generation unit is a thermoplastic polymeric material suitable for use in making the food container of the present invention. As such, a variety of thermoplastic polymeric materials may be used for making the food container of the present invention, including; ABS (acrylonitrilebutadienestyrene) with HDT of 170°to 220°F, Acetal, with HDT of 253°to 277°F, Acrylonitrile With HDT of 151°to 164°F, polyamide (including nylon 6, 66 and 610) with HDT of 122°to 185°F, polycarbonate with HDT of 250°to 270°F, polyester with HDT of 122°to 185°F, Polyimide with HDT of 460°to 680°F, polypropylene with HDT of 120°to 140°F, polystyrene with HDT of 169°to 202°F and Polyvinylchloride with HDT of 140° to 170°F.

The Heat Distortion Temperature referred to above is measured by following the test method described in ASTM

D648 which is a standard test method known to those skilled in the art.

Alternatively, the food container of the present invention may be made of a thermoplastic polymeric material with a glass transition temperature of at least - (negative) 20°C.

An example of a material that fulfilled all the above conditions and was able to withstand 10 cycles of repeated heating in a microwave oven, to a temperature of 100°C while containing boiling water and without distortion, shrinkage or leakage is a polypropylene material marketed, under the trade name of TOP PLENE P6H-02, by Topping Chemical Industries Co., LTD. Of Taiwan . This material was injection molded into a food container as described in this application. Its Heat Distortion Temperature, as measured in accordance with ASTM Test Method No.D648, is 128°C. Other grades of polypropylene were also used for making a thermoformed food container in accordance with the present invention which also yielded similar successful results. From a cost, processability, performance and appearance standpoints, the most preferred material for implementation of the present invention is polypropylene. Polystyrene, and

in particular impact-modified polystyrene, is also a good alternative.

Other structural features of the present invention are presented on the attached drawings which are self explanatory. For example, the living hinges located at the bases of the handles make it possible to stack a number of food containers on top of one another as customarily done in the Chinese food service industry.

In accordance with the present invention, two methods are preferred for producing the food container. These methods are injection molding and thermoforming.

The above described and shown, in the accompanying drawings, food container overcomes the performance limitations that prior art food containers suffer. An example of such prior art food containers is described in U.S. Patent No.5,411,204 which is incorporated in this application in its entirety by reference. Other related U.S. Patents which are incorporated in this application in their entirety, by reference are Nos. 5,669,552, 6,206,280, 5,803,264, 5,855,315, 5,873,220, 6,050,483, 5,947,368,

5,588,584, 5,484,102, 5,474,231, 5,409,160, 5,351,881, 5,288,012, 5,060,451, 6,386,441 and 6,189,779.

The present invention eliminates the need to pre-fold a pre-cut cardboard, shape it into a container form and attach the four generated folded gussets (one at each corner of the rectangle) to the sides of the container, as taught, for example in U.S. Patent Nos. 5,411,204 and 5,873,220. In addition, since no folded gussets are present in the container of the present invention, the possibility of leakage occurring from the low point of the folded gusset (point Q in Figure 3 of U.S. Patent No. 5,873,220, (Drawing attached)), it is possible to fill the container of the present invention, with liquid and without leakage, to a higher level than it is possible to do so with the containers taught in the prior art, for example in U.S. Patent Nos. 5,411,204 and 5,873,220.

When the container of the present invention is made by the injection molding method, it is preferable that the thermoplastic polymeric material used has a melt flow index of at least 20 g/10 minutes. The melt flow index, also known as the melt flow rate is measured by an experimental procedure known to those skilled in the art as ASTM D1238.

An example of a thermoplastic polymeric material which has been used successfully to produce the container of the present invention is a polypropylene grade "COSMOPLENE AX 164" marketed by the tpc company (The Polyolefin Company (Singapore) Ltd.). This material has a HDT of 122 C and a melt flow rate (melt index) of 50 gm/10 minutes.

In accordance with the present invention, the thickness of the wall of the container is preferably within the range of 0.006" to 0.060" and may be varied within the same container wall yet preferably remaining within that range. Of course, stiffeners or thicker areas may be integrally added to wall 3 in order to enhance the overall rigidity of the container. The low limit of the above mentioned range is usually possible when the container is manufactured by the thermoforming process which yields thickness variations among as well as within the various sections of the container. Injection molding, however, provides more positive control on the wall thickness by adjusting the spacing between the two mating/matching halves of the mold to produce the desired thickness at every zone/segment/portion/point of the container.

In a thermoformed container produced in accordance with the present invention, utilizing a thermoforming grade polypropylene sheet of 0.027" thickness, the wall thickness varied from 0.006" at the bottom of cavity 2 to 0.016" at the top of cavity 2, i.e., near joining line 9.

In an injection molded container produced in accordance with the present invention, a substantially uniform container wall thickness of 0.019" was selected and the matching mold halves were machined to generate the desired spacing (of approximately 0.019") between them. The living hinges (at joining lines 9 and crease lines 10) had a lower thickness so that any attempt to deflect flaps 8 towards or away from the container would result in a fold/bend around lines 9 and/or 10. For example, living hinges 9 and crease lines 10 of 0.0045" thickness have been utilized in an injection molded container made in accordance with the present invention. The ratio of stiffness of the areas immediately adjacent to lines 9 and 10, in this case, is $(0.019/0.0045)^3 = (4.22)^3 = 75.27$. In accordance with the present invention, the ratio of the thickness of joining lines 9 and/or crease lines 10 to the thickness of the respective areas immediately adjacent to them is not to exceed 0.8. As such the ratio of bending rigidity of

joining line 9 and/or crease line 10 to the bending rigidity of the respective areas immediately adjacent to them is not exceeding 0.55. As such, joining lines 9 and/or crease lines 10 will always have a tendency to direct any bending action applied in their respective vicinities to readily form a fold line.

Joining lines 9 and crease lines 10 may also be made more readily tearable/frangible by providing perforations, micro-perforations, slits or some other structural weakness along their lines. It is also preferable to have joining lines 9 start and/or end with notched areas in order to facilitate the tearing action which an end user may wish to do in order to remove/tear off flaps 8 from the cavity section 2 of container 1.

The present invention also teaches two methods for manufacturing food containers, featuring the above described geometric characteristics and performance characteristics. The first method is through the use of injection molding and comprises the steps of:

Providing a thermoplastic polymeric resin injection mold comprising a core segment and a cavity segment, said core and cavity segments being so shaped as to mate and create a space between them in the form of i) a continuous seamless

periphery, said periphery having no folded gussets and is preferably polygonal in shape, for example; square, rectangular, pentagonal, hexagonal or octagonal. Said periphery also having a top peripheral portion and a bottom peripheral portion and ii) a bottom surface, said bottom surface being uninterruptedly in continuous spatial communication with said bottom peripheral portion, thereby creating a space between said core segment and said cavity segment in the form of a continuous cavity corresponding to cavity 2. Said core segment and said cavity segment being further shaped to create a space between them in the form of a set of at least two flaps. Said flaps having base ends and free ends, said base ends being substantially of the same length as two opposite sides of said top peripheral portion and being located parallel and adjacent to said two opposite sides of said top peripheral portion. Said space creating said flaps being connected to said space corresponding to said cavity through a restriction zone of a spacing not exceeding 0.8 of the spacing corresponding to said top peripheral portion and the space corresponding to said flap base, thereby creating a space corresponding to a fold line connecting the space corresponding to said flap base to that corresponding to said top peripheral portion.

Injecting a molten thermoplastic polmeric material in said spacing, said thermoplastic material having a glass transition temperature of at least -(negative) 20 degrees Celsius and/or a Heat Distortion Temperature, measured as described earlier, of at least 48 degrees Celsius.

Cooling said injected molten thermoplastic polymeric material thereby solidifying the molten polymeric material injected in the above described spacing, opening said mold and ejecting the formed food container.

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